and must be used. If *T. polycarpum* Loret is validly published, then *T. polycarpum* Wats. becomes a later homonym and *T. ametrum* Greene (or some other synonym; I do not know the taxonomy) must be taken up.

In view of the imperfect elaboration of the rule as to provisional names, the only safe course seems to be to admit as validly published under it only names which conform closely to the example from de Wildeman given. He had a plant which he unreservedly accepted as a new species, but he was in doubt as to the genus to which he should refer it, and called it both *Cymbopogon Bequaerti* and *Andropogon Bequaerti.* According to the rule, both these names are validly published. But if de Wildeman had written: "I do not feel justified in describing this as a new species; but if I were to do so, I should call it either *Cymbopogon Bequaerti* or *Andropogon Bequaerti*"—that is, if he had not definitely accepted the species[2]—then, as I see it, both names would be provisional and not validly published.

The hypothetical quotation is very near what Loret actually did. On the above basis, then, *T. polycarpum* Loret is a provisional name, not validly published and incapable of functioning as an earlier homonym, and *T. polycarpum* S. Wats. is the correct name for the species.

Gray Herbarium, Harvard University,
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THE ANATOMY OF REDWOOD BARK

Irving H. Isenberg

This paper is one of a series originating from the laboratories of The Institute of Paper Chemistry, Appleton, Wisconsin, and covering a fundamental study of the botanical, chemical and other characteristics of the California redwood; this work has been sponsored by The Pacific Lumber Company, Scotia, California. The present paper is a portion of a botanical study made by the author at the Institute in 1939. Although considerable data have appeared in the literature on the anatomy of the wood of *Sequoia sempervirens* (see J. N. Mitchell, Jour. Forestry 34: 988–93. 1936 for discussion and list of references) the only published work on the anatomy of redwood bark seems to be that included in the article by Abbe and Crafts, who examined the phloem of white pine and other coniferous species (L. B. Abbe and A. S. Crafts, Bot. Gaz. 100: 695–722. 1939). Their studies

[2] On this point—the only definition of a provisional name we have—see Int. Bot. Congress. 1930. Nomenclature. Prop. Brit. Botanists 16 (art. 44); Rec. Synopt. 41 (art. 37 ter).

were apparently confined to the inner bark and stressed maturation of the sieve cells.

The bark of a merchantable redwood tree, *Sequoia sempervirens* (Lambert) Endlicher, is composed of secondary phloem, living and dead, and of periderm. The redwood is a thick-barked tree; the bark is sometimes as much as a foot thick but is usually much less. In external appearance it is reddish, deeply furrowed, and scaly. In transverse section the bark appears as two strikingly different colored rings—the very thin, whitish, inner one and the thicker, reddish-brown, outer one. The light-colored layer, which may have a pinkish tinge, rarely exceeds one quarter of an inch in thickness.

Primary Body

Although the primary bark tissues disappear early in the life of a redwood tree, a brief review of their structure seems to be in order before proceeding to a more detailed study of the secondary phloem. The primary body is self-sufficient and contains all the fundamental tissues and body parts. A cross section of a redwood stem at the end of the first growing season shows (pl. 6) the pith, primary xylem, cambium, primary phloem, cortex, and epidermis, as well as the secondary xylem and phloem. An accessory protective layer, the hypodermis, is located just beneath the epidermal layer. A few longitudinal resin canals are also evident in the cortex in plate 6.

The primary tissues lying outside the cambium are pushed outward by the development of secondary tissues. The increase in circumference to which these tissues must accommodate themselves quickly surpasses their ability to respond, with the result that, sooner or later, they are crushed or ruptured and killed by exposure, and especially by the stoppage of food and water supplies by the cork layers which develop within them. Obviously, the secondary phloem is very important functionally to the tree, because it soon replaces the primary phloem.

Secondary Phloem

The secondary phloem of redwood contains four types of cells—sieve cell, longitudinal parenchyma, fiber, and ray parenchyma (pl. 8).

The sieve cell is the cell characteristic of secondary phloem from the viewpoint both of structure and function. In some specimens of redwood bark examined, the sieve cells comprised the majority of the cells, both in the inner living and in the outer dead bark; in others, there occurred greater amounts of phloem parenchyma. Similar to other gymnosperms, the sieve cell elements are not arranged in series, end to end, forming definite conducting lines, but are separate and distinct. The sieve plates are scattered irregularly on the radial walls of the sieve cell ele-

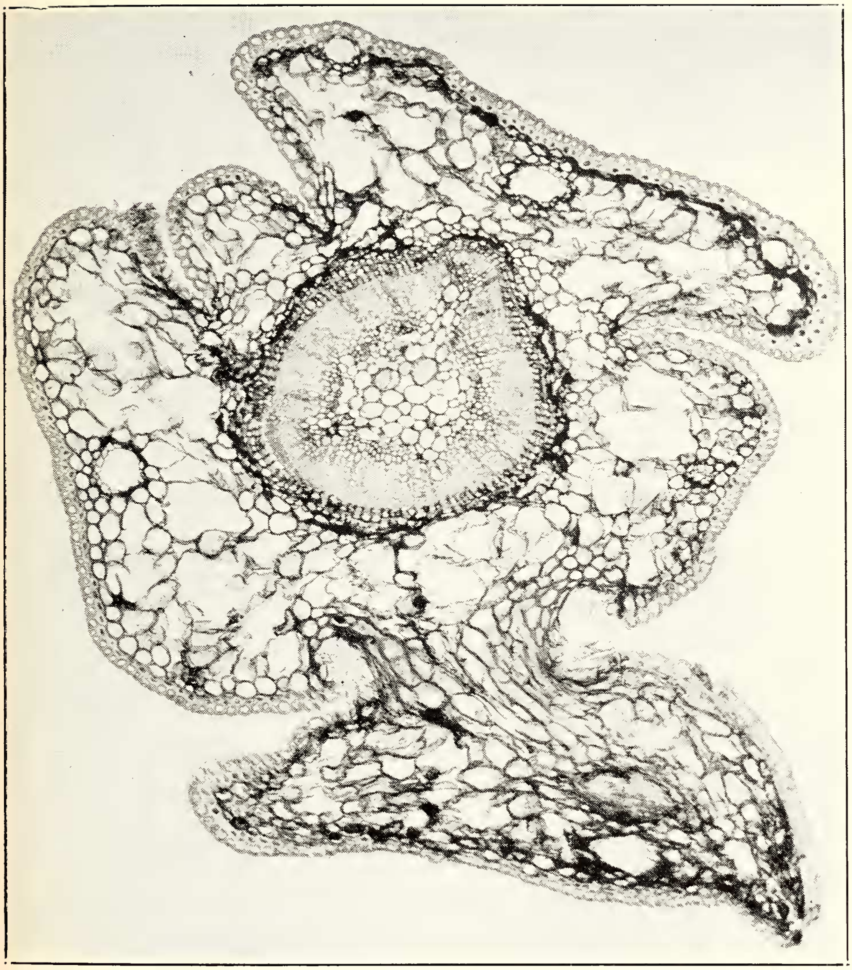

Plate 6. Sequoia sempervirens. Cross section of one year old stem. ×73.

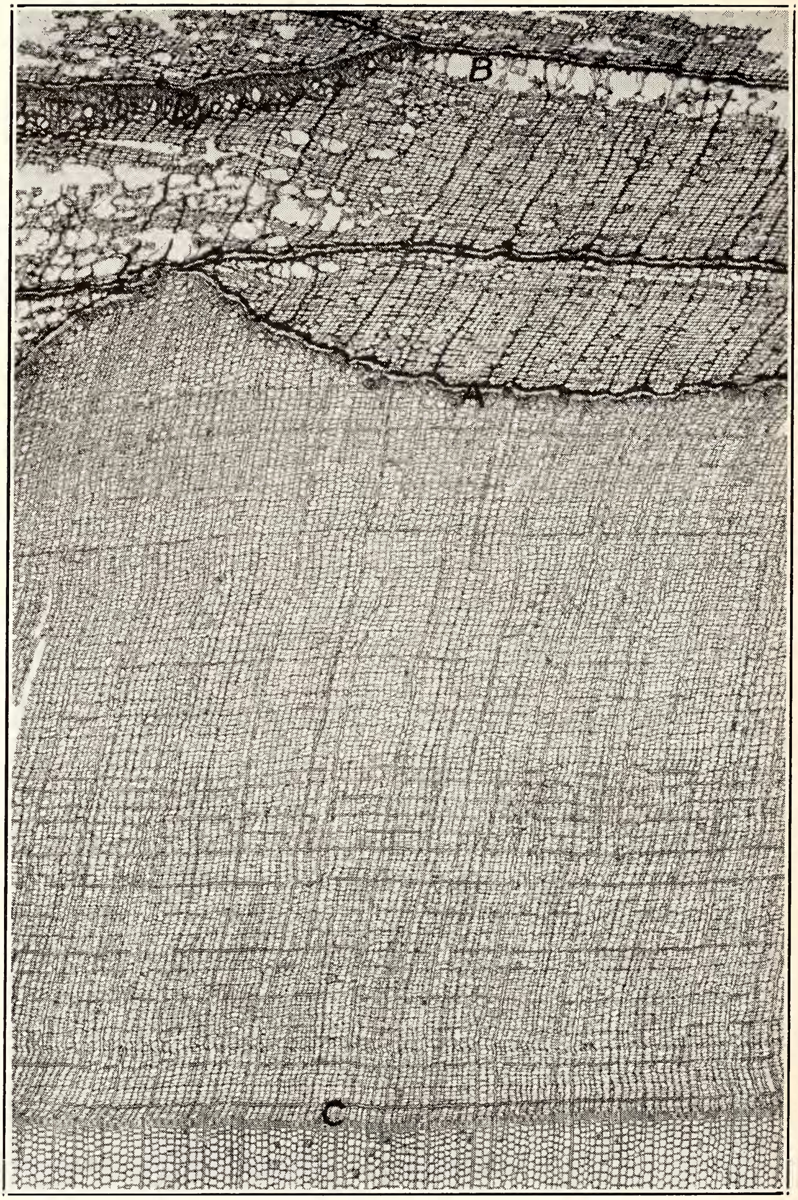

Plate 7. Sequoia sempervirens. Cross section of inner and small part of outer bark. ×20. A, last-formed periderm; B, dilated phloem parenchyma; C, cambium; D, "reinforced" area.

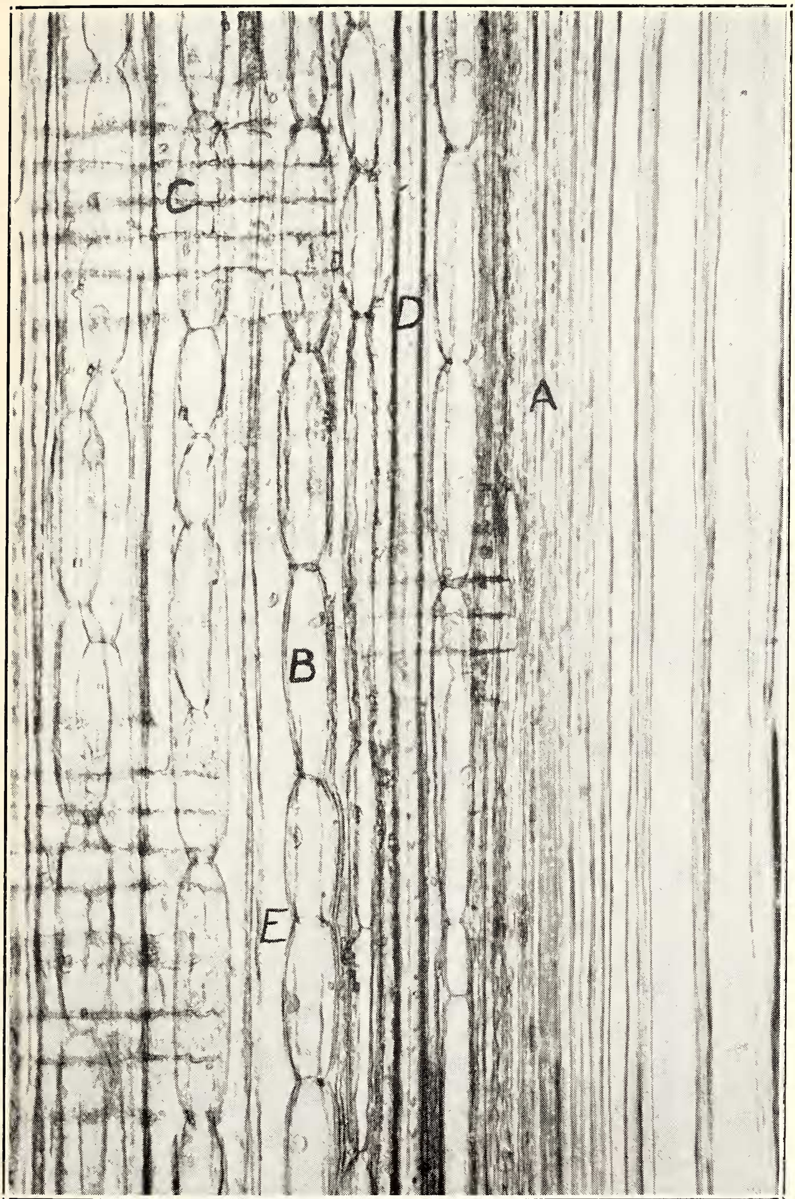

PLATE 8. SEQUOIA SEMPERVIRENS. Radial section of inner bark and sapwood. ×200. A, cambium; B, phloem parenchyma; C, ray; D, fiber; E, sieve cell.

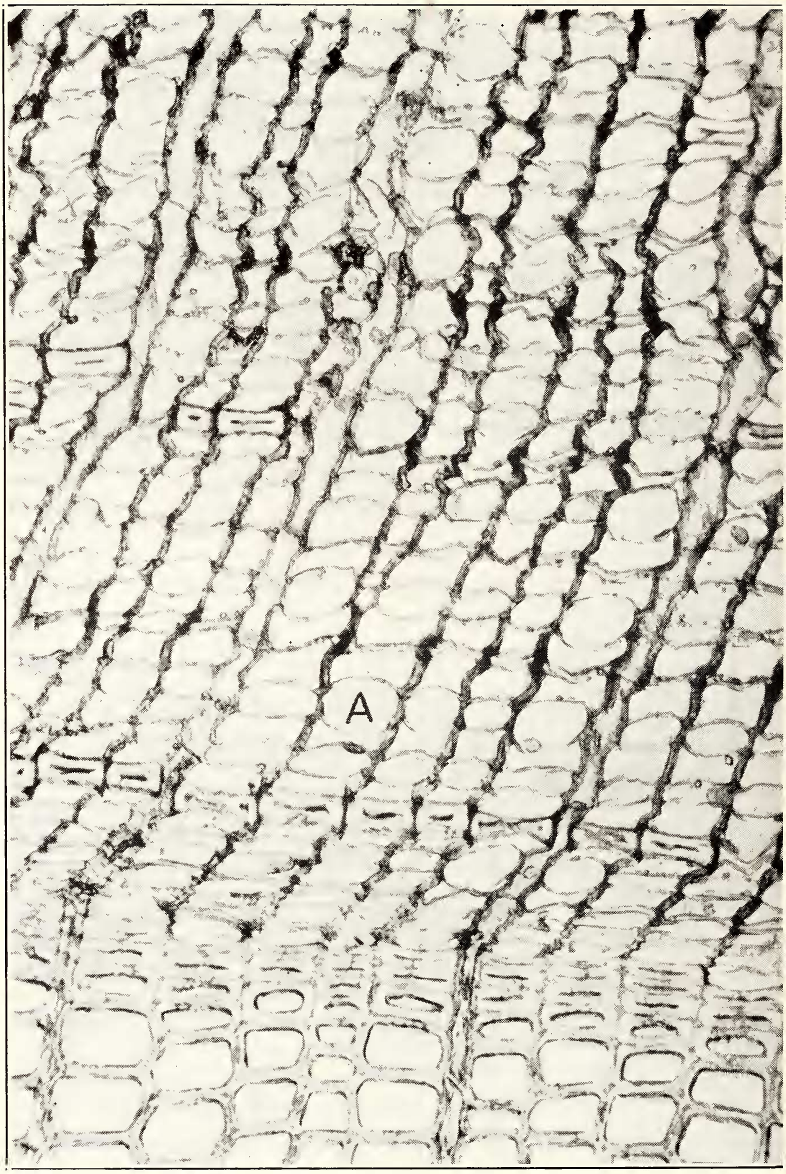

Plate 9. *Sequoia sempervirens.* Cross section of inner bark. $\times 200$. A, phloem parenchyma.

ment; their diameter is only slightly less than that of the sieve cell. Painstaking work by Abbe and Crafts has revealed many interesting details in the living sieve cells in *Sequoia sempervirens* and other coniferous species, especially *Pinus strobus.*

The phloem parenchyma cells are rectangular, or more or less rounded, in cross section because of bulging tangential walls (pl. 9, A), with the larger dimension tangential. The height of the cell is several times greater than either transverse dimension. When the parenchyma cells appear rectangular in transverse section, it is impossible to distinguish them from sieve cells. It is very easy, of course, to separate parenchyma and sieve cells in either longitudinal plane because of their great difference in length and also because of the presence of sieve plates in the walls of the latter. The average length of phloem parenchyma cells is 180 microns, ranging from 110 to 300 microns.

The phloem fibers are arranged in tangential uniseriate rows which occur rather regularly (pl. 10). These fibers are of economic interest. However, although the bark of the redwood tree is termed fibrous, it does not, unfortunately, contain a very large percentage of fibers by weight. The frequency of formation of these uniseriate rows of fibers cannot be determined in older sections of bark because of the formation of periderm and the sloughing of outer dead bark. Examination of several smaller stems suggests that approximately one row of phloem fibers is formed each year, at least during the first ten years. Later they appear to be formed less frequently. It seems more probable, however, that the number of rows and the dimensions of the fibers are dependent upon environmental factors. The average length of more than 300 fibers was 6.73 mm., ranging from 3.0 to 9.6 mm., with a standard deviation of $\pm$ 0.14 mm. The average tangential diameter was 46 microns and the average radial diameter was 18 microns. As might be expected, the individual data covered a much greater range in radial than in tangential dimension. The fibers have a very thick wall and a slit-like lumen. Simple pits occur on the radial walls.

The phloem ray consists entirely of parenchyma cells. These rays are usually uniseriate, although not infrequently some biseriate rays occur. In height they varied from one to many (about 27) cells, or approximately 700 microns. The average length of the ray cell was 130 microns, ranging from 80 to 250 microns. There were approximately four rays per millimeter tangentially, as measured on the cross section. Abbe and Crafts have reported relatively fewer albuminous cells in the phloem rays of redwood than in white pine. In the present study short rows of erect marginal cells were found very close to the cambium in a few of the phloem rays.

The tissues of the secondary phloem of redwood appear to be arranged in definite tangential bands (pl. 7), as a result of